

while lying on or moving across the bottom. In Lambis the specialized foot and operculum permit locomotion and righting on sand, while the heavy shell, broad outer lip, and marginal spines help prevent overturning of the unattached animal in turbulent water and sinking in while moving across soft sand (see Yonge, 1932).

In Terebellum no such stability in orientation is provided by the narrow, fusiform shell, and the very rapid and effective righting response seems related to the hazard of being frequently overturned. Leaping in Terebellum, as described in the quotation from Adams, was not noted in the present observations, though the animals taken wriggled the foot rapidly and to such effect that the first specimen taken in hand was immediately dropped. This ability, plus the periscopic "watchfulness" of the eyes during burrowing, suggest adaptations of value in protection and escape.

### Literature Cited

- Bergh, Ludwig S. Rudolph  
1895. Beiträge zur Kenntnis der Strombiden, besonders der Gattung Terebellum Klein. Zool. Jahrb. Abt. Anat. Syst. 8: 342-378; pls. 22-23.
- Colton, H. S.  
1905. Some notes on living Strombus pugilis. Nautilus 19 (8): 85-88; pl. 3, figs. 11-13.
- Morton, John E.  
1958. Molluscs. Hutchinson, London. pp. 1-232; figs. 1-23.
- Pelseneer, P.  
1906. Part 5. Mollusca, in: Lankester, E. R., ed., A treatise on zoology. Black, London. 5: 1-355; figs. 1-301.
- Robertson, R.  
1961. The feeding of Strombus and related herbivorous marine gastropods; with a review and field observations. Notulae Natur. Acad. Nat. Sci. Phila., No. 343: 1-9; fig. 1.
- Thiele, Johannes  
1931. Handbuch der systematischen Weichtierkunde. Fischer, Jena. 1: 1-778; figs. 1-783.
- Tryon, George W., Jr.  
1880. Manual of conchology, 2: 1-289; pls. 1-70.  
1885. Manual of conchology, 7: 1-309; pls. 1-58.
- Yonge, C. M.  
1932. Notes on feeding and digestion in Pterocera and Vermetus, with a discussion on the occurrence of the crystalline style in the Gastropoda. Brit. Mus. (Nat. Hist.) Great Barrier Reef Exped. Sci. Repts. 1 (10): 259-281; figs. 1-6; tables 1-3.
1937. The biology of Aporrhais pes-pelecani (L.) and A. serresiana (Mich.). J. Mar. Biol. Assn. U. K. 21: 687-703; figs. 1-6.

## The Search for Turritella jewettii CARPENTER

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During the years 1864 to 1866, Philip P. Carpenter described two species of Turritella from southern California, T. cooperi and T. jewettii. So far as is known, neither species is represented by a designated type specimen, although material on which Carpenter may have based T. cooperi is in the collections of the Museum of Paleontology, University of California (Durham in Palmer, 1958, p. 168). There is little doubt but that the slim turritellid especially common in Plio-Pleistocene, Pleistocene, and Recent faunas of southern California is indeed T. cooperi, and this point is accepted without further question here.

During the preparation of her invaluable memoir on the types of Carpenter's west coast marine shells, Palmer (1958, pp. 169-170) made an extensive search for type material of Turritella jewettii. No specimens certainly identified by Carpenter as T. jewettii are known. All specimens that she found identified as T. jewettii and dating from Carpenter's time have proven to be T. cooperi, commonly young individuals. Cooper was evidently responsible for many of these sets. Merriam [1941, pp. 119 (footnote), 123] suggested that T. jewettii might have been based upon a fairly smooth variant of T. cooperi.

Turritella jewettii was based upon material included in ". . . a very interesting series of Pliocene fossils from the neighborhood of Santa Barbara" (Carpenter, 1864, p. 539). The locality is further described as being ". . . two miles from the coast, and 150 feet high" (Carpenter, loc. cit.). Carpenter's list of 45 forms in Jewett's collection leaves no doubt but that the fossils are from the Santa Barbara formation. Turritella jewettii was not well described until later (Carpenter, 1866b, p. 276). By that time Carpenter had specimens from San Diego that he identified as T. jewettii also. His remarks are "San Diego, on beach (Cassidy)", and "Mr. Cassidy's specimens may be washed fossils, or very poor recent shells" (Carpenter, loc. cit.).

Arnold (1903) identified as Turritella jewettii a species that is found in the Pleistocene at San Pedro but which is not certainly known to occur either in the Santa Barbara or San Diego regions. Arnold's T. jewettii did not agree very closely with Carpenter's description and so was redescribed as T. pedroensis by Applin (MS.; Merriam, 1941, pp. 121-123, pl. 35, figs. 1-9).

Until recently the only species of Turritella known to occur in the Santa Barbara formation aside from Carpenter's record of T. jewettii was T. cooperi, lending support to the hypothesis that T. jewettii was based on variants of T. cooperi. Turritella cooperi living and fossil occurs also at San Diego. However, recent collecting has resulted in the discovery of a second species of Turritella in the Santa Barbara formation (Valentine, 1962). This species is identified as T. hemphilli Merriam (Merriam, 1941, pp. 126-127, "Turritella vanvlecki subsp. hemphilli Applin MS"). The type of T. hemphilli is from the San Diego formation at Pacific Beach. Might the species called T. hemphilli be the lost T. jewettii of Carpenter?

In the Santa Barbara formation, Turritella hemphilli has been found at two localities in the Rincon Creek area (only half a mile from the ocean) and in an outcrop on Fairview Avenue (1.1 miles north of Goleta and 2.65 miles north of the ocean). All these localities are near 150 feet in elevation. Turritella hemphilli is associated with diverse molluscan assemblages that resemble the collection of Jewett as recorded by Carpenter. No specimens of T. hemphilli were found in the Packard's Hill region, although some localities there have yielded associations similar to Jewett's collection also.

Carpenter's original description of Turritella jewettii in Latin is readily available

(1866b; reprinted, 1872; Oldroyd, 1927, p. 54 — note that the word "distantibus" in Carpenter's description is incorrectly given as "distinctibus" in Oldroyd). A translation has kindly been rendered by Professor Anna S. Benjamin, Department of Classical Languages, University of Missouri.

Shell turreted, quite terete and not at all thin; ashy yellow-red in color; whorls nearly flat, sutures distinct; surrounded by separate small ridges (of which two are rather prominent on the younger shell) and by subobsolete spiral furrows; base not very angulate; aperture subquadrate; lip thin, moderately sinuous [translation of Carpenter, 1866b, p. 276, lines 6-10].

This description closely fits Turritella hemphilli which has fine spirals with commonly two heavier spiral bands on early whorls which are themselves sculptured by fine spirals. On later whorls the heavy spirals decrease in strength and become obsolete while their fine spirals merge with those on the rest of the shell (well shown in Merriam, 1941, pl. 37, fig. 13; see also forms figured as T. vanvlecki teglandae, same plate).

It is interesting to contrast this description with that of Turritella cooperi (Carpenter, 1866a, also translated by Professor Benjamin). Turritella cooperi is described as rather thin, and T. jewettii as not at all thin; T. cooperi has two ridges, and T. jewettii has small ridges, two of which are especially pronounced on juvenile whorls; the base of T. cooperi is angulate, but of T. jewettii not very angulate; and T. cooperi has an exceedingly sinuous lip, while T. jewettii has only a moderately sinuous lip. It certainly appears that Carpenter had two fairly distinct forms at hand, and though it is conceivable that these differences could be between two variants of T. cooperi, they are also strikingly like the differences between T. cooperi and T. hemphilli.

Carpenter volunteered an additional bit of information about Turritella jewettii: it is ". . . nearest to T. sanguinea, Rve., from the Gulf, but differs in the faintness of the sculpture" (Carpenter, 1866b, p. 276). Turritella sanguinea is evidently a South African species incorrectly assigned to "California" by Reeve (1849, species 27, pl. 6, fig. 27). Carpenter's early references to it are based on Reeve's record (Carpenter, 1857). Later Carpenter lists it from La Paz (1864, p. 622), though it is not certain whether or not the identification was his own. If it was, he must have had some Gulf of California species in mind.

Four species are known to include La Paz in their present ranges: Turritella gonostoma, T. leucostoma, T. mariana, and T. nodulosa. Of these, T. mariana and T. nodulosa look so little like Carpenter's description of T. jewettii, which "T. sanguinea" is said to resemble, as to be immediately eliminated as candidates for a form that Carpenter identified as T. sanguinea. Both of the other species were known to Carpenter who lists them in early reports. The whorls of T. leucostoma are contracted anteriorly, and sculptural details do not agree well with Carpenter's description of T. jewettii. Turritella gonostoma is closely allied to T. hemphilli and may be conspecific with it.

A shell from South Africa identified as Turritella sanguinea and closely resembling Reeve's figure is at hand; it has rather fine spirals as Reeve's figure suggests, but stronger than those on adult T. hemphilli. It is dissimilar to both T. hemphilli and T. cooperi and resembles T. gonostoma only vaguely in color pattern. It does not seem that Carpenter's reference to T. sanguinea can be used at present as strong evidence in establishing the identity of T. jewettii, though it serves to emphasize that the sculpture of T. jewettii is weak.

In summary, the distribution of Turritella hemphilli and its close agreement with Carpenter's description of T. jewettii suggests that these two forms may be identical. If this suggestion is accepted, T. jewettii has priority and must replace T. hemphilli. A neotype in better condition than the specimens at hand would be desirable.

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### Literature Cited

- Arnold, Ralph  
1903. The paleontology and stratigraphy of the marine Pliocene and Pleistocene of San Pedro, California. Mem. Calif. Acad. Sci. 3: 1-149; pls. 1-37.
- Carpenter, Philip Pearsall  
1857. Report on the present state of our knowledge with regard to the mollusca of the west coast of North America. Brit. Assoc. Adv. Sci., Rept. 26th Meeting: 159-368; pls. 6-9.
- \_\_\_\_\_, \_\_\_\_\_  
1864. Supplementary report on the present state of our knowledge with regard to the mollusca of the west coast of North America. Brit. Assoc. Adv. Sci., Rept. (1863): 517-686.
- \_\_\_\_\_, \_\_\_\_\_  
1866a. Descriptions of new marine shells from the coast of California. Pt. III. Calif. Acad. Sci. Proc. 3: 207-224.
- \_\_\_\_\_, \_\_\_\_\_  
1866b. On the Pleistocene fossils collected by Col. E. Jewett, at Santa Barbara, California; with descriptions of new species. Ann. Mag. Nat. Hist., ser. 3, 17: 274-278.
- \_\_\_\_\_, \_\_\_\_\_  
1872. The mollusks of western North America. Embracing the second report made to the British Association on this subject, with other papers; reprinted by permission, with a general index. Smiths. Misc. Coll. 252: 1-325; index.
- Merriam, Charles W.  
1941. Fossil turritellas from the Pacific Coast region of North America. Univ. Calif. Pubs., Bull. Dept. Geol. Sci. 26 (1): 1-214; pls. 1-41.
- Oldroyd, Ida Shepard  
1927. The marine shells of the west coast of North America. Stanford Univ. Pubs., Geol. Sci. 2 (3): 1-339; pls. 73-108.
- Palmer, Katherine Van Winkle  
1958. Type specimens of marine mollusca described by P. P. Carpenter from the west coast (San Diego to British Columbia). Geol. Soc. Amer. Mem. 76: 1-376; pls. 1-35.
- Reeve, Lovell Augustus  
1849. Conchologica Iconica. Vol. 5, Turritella. London, L. Reeves & Co.
- Valentine, James W.  
1962. Molluscan biofacies of the Santa Barbara formation, California (Abstract). Geol. Soc. Amer., Spec. Papers 62: 289.

